CHAPTER 5

Southern Forest Communities

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The southern forest is contrasted with the northern forest by the ecological importance of several species of oak and by the presence of several tree species normally not found north of the tension zone

Description

Describing forests in southern Wisconsin (south of the tension zone) is more difficult than describing forests in northern Wisconsin. One complication is that this region includes both glaciated and unglaciated landforms, which together include soils that range in age from 15,000 to perhaps 750,000 years. Another complicating factor is the important role of fire during a period lasting perhaps 5,000 years, up to the time of Euro-American settlement, with the peak of this xerothermic period occurring 3,500 years ago.

In broadest terms, the *southern forest* is contrasted with the northern forest by the ecological importance of several species of oak (red, white, black, bur, northern pin, and swamp white) and by the presence of several tree species normally not found north of the tension zone (shagbark hickory, hackberry, boxelder, and black walnut). Bitternut hickory and butternut, which occur only occasionally in northern forests, are common although not abundant in the south. Equally important is the general absence of conifers (white spruce, balsam fir, hemlock). Pines, especially jack pine, occur in scattered areas of sandy soils.

Curtis (1959) classified southern Wisconsin forests into five community types, based on existing overstory composition: wet, wet-mesic, mesic, dry-mesic, and dry. Only the upland types (mesic, dry-mesic, and dry) will be considered here. Mesic forests are characterized by the dominance of so-called mesic hardwoods, mainly sugar maple, basswood, and American beech in the extreme eastern part of the state. Ironwood, American elm, and white ash are common associates. Dry-mesic forests are dominated by red and white oak, and dry forests are dominated by black, white, and bur oak. Hickories are common associates in both dry-mesic and dry types, while mesic hardwoods are frequently present as less important associates in dry-mesic types.

A system of finer divisions into "habitat types" based on ground layer and shrub species as well as canopy species has been developed by Kotar et al. (1988). The system has been valuable in developing forest management plans for specific sites. This system takes into account the fact that all tree species have wide ecological amplitudes and often occur as temporary dominants on sites where they do not maintain themselves in competition with other species. For example, stands dominated by red and white oak may occur as a result of fire disturbance on both mesic and dry-mesic sites. However, the associated flora on the two sites will differ significantly. Thus the two communities are less alike than their canopy composition would suggest. Also, with the exclusion of fire, the oak community on the mesic site will

rapidly succeed to mesic dominants, whereas the community on the dry-mesic site will either remain as an oak-dominated community or will succeed to mesic species over a much longer period.

Because the function of an ecosystem is dependent on both its biotic and abiotic makeup, it is important to distinguish between communities with different overall species composition. In other words, two communities dominated by the same trees species may be functionally very different. If biological diversity is to be a factor in the development of management strategies, our understanding of relationships between physical site and community composition must be enhanced.

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Status

Past

Post-Glacial Environment

Only the eastern half of the state south of the tension zone was glaciated during the most recent stage of the Pleistocene. The relationship between various glacial landforms and basic soil types, as outlined in the section on the northern forest, also applies here. Most of the southwestern portion of the state, known as the Driftless Region, has escaped glaciation at least over the last 750,000 years. However, contrary to common belief, the region was not entirely surrounded by ice at any time; thus there was always an open route for migration of flora and fauna. In fact, the significance of the Driftless Region has more to do with its function as a source of flora and fauna for post-glacial reinvasion of glacial regions than it does with uniqueness of its soil parent material. Most of Wisconsin's landscape is covered by varying depths of wind-blown silt (loess), originating in the Mississippi floodplains. Thus the composition of the soil parent material and age of soils in glaciated and driftless regions differ less than would be expected.

Current floristic distribution in the state suggests that enough time has elapsed since the retreat of the continental ice sheet for most plants and animals to reach suitable habitats. Current differences in species composition of communities in similar environments are presumed to be due to differences in disturbance histories and chance events.

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Composition of Presettlement Forests

As is true for the northern forest, the exact nature of the floristic and structural composition and the geographic variation of the southern forest before Euro-American settlement has never been described and will probably never be known with certainty. However, descriptions and occurrences of prominent forest types, at least in terms of tree species composition, were recorded by numerous early observers (e.g., Knapp 1871, Chamberlin 1877, Warden 1881). These observers recognized southern forests as distinct from northern types even though many tree species occurred in both regions. The predominance of oaks and general absence of conifers were key distinguishing features noted by all observers. Another feature of southern forests often singled out by early travelers was the relative openness or park-like appearance due to the lack of small trees and shrubs. For example, one could easily ride on horseback through the woods, a condition much less common in northern forests.

The best source of information on the composition of vegetation in Wisconsin

during the earliest period of Euro-American settlement comes from the records of the rectangular survey of public lands (General Land Office Surveys). The nature of these records and methods used to interpret them for purposes of constructing maps of presettlement vegetation have already been summarized in the section on the northern forest community. A simplified map of presettlement vegetation constructed from survey records by Finley (1976) is shown in Figure 10.

Seven of the 11 forest types recognized by Finley occur in northern Wisconsin and have already been described. The four southern types are as follows:

- Sugar maple-basswood with red oak, white oak, or black oak as major associates. This type of forest occurred in three major blocks, one centered in Richland and Vernon counties, another in Washington and Dodge counties, and a third in Pierce County. Numerous small segments occurred in other counties, particularly Grant, Green, Lafayette, and Sauk counties.

- American beech—sugar maple—basswood with red, white, or black oak as major associates. This type was similar to Type 1 above, except that beech was often dominant or shared dominance with sugar maple. This type occurred in a narrow north-south belt along Lake Michigan. It also coincided with the geographic range of beech in southern Wisconsin.

- White-oak—black-oak—bur-oak. This loosely defined type occurred in a seemingly random pattern throughout the region south of the tension zone.

- Oak openings: bur oak—white oak—black oak. This savanna community type often occurred as a transition between oak forest and prairie. This type could not always be distinguished from Type 3 on the basis of surveyors' records. Often it was not possible to determine whether the trees occurred in a close enough spacing to represent a true forest or whether they occurred as openings or savanna. This forest type is discussed in detail in the "Oak Savanna communities" section of this report.

Factors Controlling the Dynamics of Presettlement Forests

Explaining the composition, distribution, and dynamics of southern Wisconsin's forests has been a challenge to plant ecologists and foresters for generations. Although we do not yet have all the answers, a consensus is emerging on many issues. Over the last century, the region south of the tension zone has been regarded by some as part of the more extensive eastern oak-hickory forest or even oak savanna (Kuchler 1964) and by others as maple-basswood forest (Daubenmire 1936, Braun 1950). The presence in the region of both mesic maple-basswood forests (greatly resembling the clearly mesic northern hardwoods forests) as well as drier oak forests and even savannas and prairies caused much misunderstanding and confusion. However, ecological evidence accumulated to date clearly suggests that without regular, moderate to severe fire disturbance, southern Wisconsin's climate **can** support mesic forests on most loamy soils. Only on sands or shallow loams on southern and western exposures can oak forests be expected to persist. Without fire, perpetuation of prairies and savannas, including oak openings, is virtually impossible.

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There is ample evidence that the vegetation mosaic at the time of Euro-American settlement was largely a result of fire regimes that existed for 5,000-6,000 years prior to that time. Because of differential sensitivity of tree species to fire damage, the communities in existence prior to Euro-American settlement were clearly related to the frequency and intensity of fires. All mesic hardwoods and particularly sugar maple are easily killed by fire at all stages of growth. Oaks, on the other hand, have many adaptations to fire environment. Saplings and seedlings of all oak species native to Wisconsin resprout readily when tops are killed. Bur oak has the greatest capacity for resprouting, followed by black, white, and red oak. Mature trees also possess varying degrees of resistance to fire damage, in the same species order.

Thus, mesic forests could persist in southern Wisconsin only on those landscapes relatively free of fire disturbance. Surveyors' records clearly showed that such forests occurred where rivers or lakes formed firebreaks against fires driven by the prevailing southwesterly winds. Landscapes subject to moderate fire frequency supported oak forests, while those more frequently burned supported oak openings or other savanna types. Each of these community types, once developed, contributed toward its own perpetuation. Thus, open grasslands burned most readily while mesic forests were far less likely to burn due to their more humid interior condition, lower wind speed, and lack of flammable vegetation.

Euro-American settlers converted extensive acreages of southern forest to agriculture.

Climax and Old Growth

In the section on northern forests, we discussed how site conditions (e.g., soils, topography) limit the development of climatic climax and how the floristic composition of a community can be used to characterize and classify communities and sites. In southern Wisconsin this process is complicated by fire history. We cannot be sure that the floristic differences between two physiographic types or soil types are due to site constraints or to fire history. We are currently conducting extensive floristic sampling of forest stands stratified by site factors and presettlement vegetation types. This information should help us to better understand the dynamics of southern forest types.

The concept of "old growth," as understood in the context of northern forests, is applicable in the south only to the mesic community types, which are the only types capable of maintaining themselves without disturbance. However, old-growth dry-mesic and dry forests, while very rare today, were maintained by naturally occurring disturbances such as fire. These natural ecological dynamics are essential to the maintenance of these and other climax and old-growth communities. There are probably no true old-growth oak forests left in southern Wisconsin, with the possible rare exception of those oak forests growing on the mid-slope area of north and east slopes of very steep southwestern Wisconsin ridges. Some of these forested ridges of the Driftless Region exceed 450 feet in height, and only those portions of the side slopes that could be reached with cable were logged. This commonly left old-growth strips 200-300 feet wide at mid-slope, extending the length of the ridge. Today, those strips are imbedded in second-growth forest growing above and below.

The Logging and Euro-American Settlement Era

There was a significant difference in the impact of Euro-American settlement on northern and southern Wisconsin forests. While in the north the impact was mainly on forest composition; in the south, Euro-American settlement meant elimination and conversion to agriculture of extensive forest acreage. Forests not cleared for farming were almost universally high-graded for

lumber, fuelwood, railroad ties, and other products and were subsequently or simultaneously grazed by cattle or sheep. Because wild fires were also suppressed with Euro-American settlement, former oak savannas not used for farming rapidly transformed into oak forests of generally low economic value.

Present

Vegetation

Perhaps the most conspicuous characteristic of the present southern forest as a whole is its fragmentation. Percentage of forested area for various southern counties ranges from almost zero in some eastern counties to 30% or 35% in the western "coulee" region. The remaining forests exist mostly in small blocks or patches. Some notable larger blocks are found in the Baraboo range, the northern unit of the Kettle-Moraine State Forest and the Kickapoo River valley region. The general condition of southern Wisconsin forests is perhaps of greater concern to foresters than it is to ecologists. Red and white oak are of considerable economic value, but their supply is decreasing. The initial impact of Euro-American settlement actually resulted in an increase of oaks in present stands. Because oaks are intolerant of shade, the heavy cutting that went on for several decades after Euro-American settlement stimulated oak reproduction even in mesic forests originally dominated by maple and basswood. Subsequent selective cutting of these forests again created the environment more favorable to tolerant hardwoods. Thousands of acres of previous oak savannas not utilized for farming rapidly grew into dense oak forests through sprouting of the fire suppressed root stalks called "grubs." However, these forests are not regenerating. If mesic hardwood seed source is lacking, many of these forests will gradually break down and revert at least temporarily to shrub communities.

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Animals

The forests of southern Wisconsin prior to Euro-American settlement supported a rich fauna that included large herbivores and carnivores such as bison, elk, white-tailed deer, cougar, bobcat, and black bear, and a great variety of smaller mammals as well as wet-forest furbearers—mink, otter, beaver, and muskrat (Jackson 1961)—and a rich avifauna. Remaining habitat patches, most of them less than 125 acres, appear to still support most of the species found at the time of Euro-American settlement. Many of the generalists and adaptive species have increased their populations (e.g., deer, raccoon, skunk, red fox, robin, blue jay, and cowbird). The wild turkey has been successfully reintroduced over the past 15-20 years.

Today, except for the deer and coyote, all of the large herbivores and carnivores are absent from southern Wisconsin, and a number of them are gone from the state. These species losses and other concerns in faunal composition and survival in the southern Wisconsin forests are a result of forest fragmentation and ecological simplification brought on by the rapid spread of agriculture and urbanization along with unregulated subsistence and commercial hunting.

Birds provide the best insight into the status of southern forest animals, for birds have been far more intensively researched and are subject to more regular surveys than any other animal group. Though it remains largely intact today, this faunal group is faced with mounting problems. The passenger pigeon, a colonial forest bird that inhabited the southern Wisconsin forests, is extinct. While only two other birds, the carolina parakeet (extinct) and the swallow-tailed kite (extirpated), have been lost from the southern forest land-

scape, many species have been negatively impacted by habitat loss, reduced size of habitat area, and changes in the composition and structure of forests and woodlots. These changes have affected bird distribution and abundance to the point where many species are listed as endangered, threatened, or of special concern, and others show significant population declines.

For example, Bond (1957) noted that interior forest species preferred larger and more mesic forests, while generalists and disturbance-preferring species showed affinity for smaller, pioneering forests. In a study of southern flood-plain forest, Mossman (1988) found that at least 20 species appeared to require stands at least 40 acres in size, and some required much larger tracts. There are at least 12 songbirds that depend on forests in excess of 40 acres in size, with three requiring a minimum of 161 acres and five more requiring either 200-acre or 240-acre woodlots to have at least a 50% chance of supporting a breeding population (Temple 1988). The average size of a southern Wisconsin woodlot is currently 47 acres. Consequently, many of these area-sensitive, interior-dependent songbird species are decreasing in frequency and undergoing population declines (Ambuel and Temple 1982, Wis. Dep. Nat. Resour. 1991).

Ecological simplification has also impacted southern forest avifauna. Reduction in area is often accompanied by grazing, logging, and cutting and gathering of firewood, activities which have altered both forest composition and structure. For example, over-grazing eliminates understory grasses, herbs, and shrubs, depriving insect and foliage-gleaning foragers of a source of food. Habitat for cavity-nesting and insect-foraging birds is removed through logging and wood-gathering.

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Many observers have noticed a significant increase in forest edge bird species (Bond 1957; Howe and Jones 1977; Ambuel and Temple 1982; Robbins 1991; David Sample, Wis. Dep. Nat. Resour., pers. comm.). One species that has benefited from increased edge is the brown-headed cowbird. Brittingham and Temple (1983) have shown that the cowbird, a brood parasite on forest songbird species, has reduced reproductive success for a number of forest songbirds and may be responsible for their recent declines. An additional concern is the role that edge birds play in predation of interior species. As crows, blue jays, and grackles increase in number, so too will their predation on forest nesting birds increase. Brood parasitism and predation, along with other elements of habitat loss and modification, have combined to create "population sinks," poor-quality habitats in which populations produce deficit numbers that require subsidization from other populations (Whitcomb et al. 1981).

Mammals are much more poorly understood than are birds in relation to the southern forests. Lack of comprehensive inventories and population surveys means that most current knowledge is based on

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The extensive floodplain forest along the St. Croix River in Polk County harbors many species of interior-nesting birds, while the small patches of forest in the distance lack these bird species. *Photo by Eric Epstein.*

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observations and relatively few studies of local species populations. However, mammals in general don't seem to show the same correlations with habitat area and quality decline as birds do (e.g., species decline, or in mammals, abnormal rhythms) (Frank Iwen, UW Zoological Museum, pers. comm.). In general, forest mammals are secure, with some species' populations apparently increasing, such as voles, mice, and shrews, where understory composition and structure are well protected and maintained. There also appears to be an increase in forest mammalian predators that are capitalizing on the increased small mammal populations (Frank Iwen, pers. comm.).

The white-tailed deer has, over the last 25-30 years, expanded its range southward and is present in great abundance in southern forest and woodlots. In some areas their numbers are so great that browse impacts are readily observed by the elimination of some plant species (e.g., certain orchids and Canada yew) and reduced reproduction of cedar, oak, and maple, among others. Deer negatively affect cover for ground nesting birds. Numbers of deer continue to increase, and this species' range is expanding into all suitable habitat.

A few mammalian species have not adapted well to current conditions. Loss of forest structure and spraying for insect control in agricultural areas has posed problems for the southern forests' solitary bats. Fox squirrels also appear to be declining in southern forest edge, as these areas convert to closed forest.

Little is known about the historic or current abundance of southern forest amphibians and reptiles (herptiles). Regional distributions studies for herptiles are ongoing by a group of amateur and professional herpetologists as part of the Wisconsin Herpetological Atlas Project (Casper 1986). The DNR has been conducting an annual frog and toad survey since 1981 to determine the population trends of these species (Jansen and Anderson 1981, Mossman and Hine 1984, Mossman and Huff 1990, Huff 1992). This survey was initiated because of the concern that amphibian populations were declining for some species in Wisconsin and globally (Modern Medicine 1973, Les 1979, Hine et al. 1981, Vogt 1981)

Several southern forest amphibians are susceptible to changes in habitat structure. These primarily include the species dependent on ephemeral or vernal ponds for breeding, such as the chorus frogs, eastern gray and Copes gray tree frogs, wood frogs, and blue spotted and eastern tiger salamanders (see "Actions Causing Concern" section). Snakes associated with the southern forest that are of concern include the black rat snake, timber rattlesnake, and massasauga rattlesnake. The impacts of natural succession, forestry practices, and other land-use and management activities on these species are not well understood. The timber rattler and black rat snake are communal denning snakes whose local populations are susceptible to losses of critical hibernating sites. These and other communal denning snakes are also more vulnerable to destruction or collection since they are clustered in quantities especially during spring emergence from den sites (Robert Hay, Wis. Dep. Nat. Resour., pers. comm.). Both the massasauga and timber rattlers have seen demonstrable declines in populations throughout Wisconsin and the rest of their ranges. Both have been impacted by habitat loss and bounties which have virtually eliminated them from many areas. They are still killed because of their unfounded reputation as being very dangerous. The massasauga is the most seriously endangered species of reptile in the state, now restricted to only a few lowland hardwood forests, forest edges, and adjacent upland fields (Vogt 1981).

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Little is known about the inverte-brates of the southern forests of Wisconsin. Diversity in forest structure plays an

important role in meeting the needs of lepidopterans as well as other insects and invertebrates. Recent surveys have focused on lepidoptera, which may in the future serve as indicators of change because of their frequent association with host plants and species-specific food sources and their relative sensitivity to habitat perturbations.

Projected

Given the rate and means by which southern forest fragments in some areas, particularly southeastern Wisconsin, are being harvested and developed as rural homesites, the following trends can be expected:

- Fragmentation and reduction in size of woodlots will continue.
- Highest quality woodlands will continue to be lost.
- At the current rate of harvest, oak may cease to be a commercially viable product in the future.
- Emphasis on hardwood saw logs will in the near future shift from oak to other southern forest hardwoods such as sugar maple, black cherry, hackberry, walnut, and white ash, further reducing both long-term veneer and saw-log supply and overall species composition and stand structure.
- Forest composition will vary greatly, with both commercially and ecologically less desirable species (such as black locust, box elder, and persistent dense shrubs) replacing oak and maple forest communities in some areas.
- Poor management practices will reduce productivity, decrease long-term economic value, and diminish sustainability of the southern forest community complex.
- Fire, perhaps the most important ecological tool in establishing and maintaining oak forests, will not be employed sufficiently as a prescribed management practice.

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Actions Causing Concern

Ecological consequences of altered vegetation dynamics, as described above, are difficult to assess. There is no question that natural community diversity of the southern forest landscape has been reduced since the suppression of presettlement fire regimes, and lack of fire in the oak woodlands and forests is a concern. In addition, native vegetation is extremely vulnerable to replacement by exotics. However, there is no clear evidence that any forest plant species have been lost. The southern forest fauna, both vertebrate and invertebrate, has apparently been more severely impacted. It appears that forest fragmentation is of primary concern in terms of faunal diversity. Additionally, structural and compositional changes from intensive land-use practices, exotic and edge species encroachment, and grazing have adversely impacted southern forest fauna. The southern forest avifauna is particularly vulnerable to fragmentation and simplification.

Forest amphibians also are a primary concern because of their vulnerability to habitat changes and pesticide use in adjoining agricultural lands. Intensive forest management and woodlot scavenging can significantly open or disturb large areas of forest, which leads to siltation and premature drying of vernal ponds, reducing or prohibiting amphibian metamorphosis (Robert Hay, Wis. Dep. Nat. Resour., pers. comm.). Also of concern in these disturbed areas is the loss of structural habitat composed of large, dead woody debris, heavy loam, and thick surface litter, which are habitat characteristics essential for amphibians (Gary Casper, UW-Milwaukee, pers.

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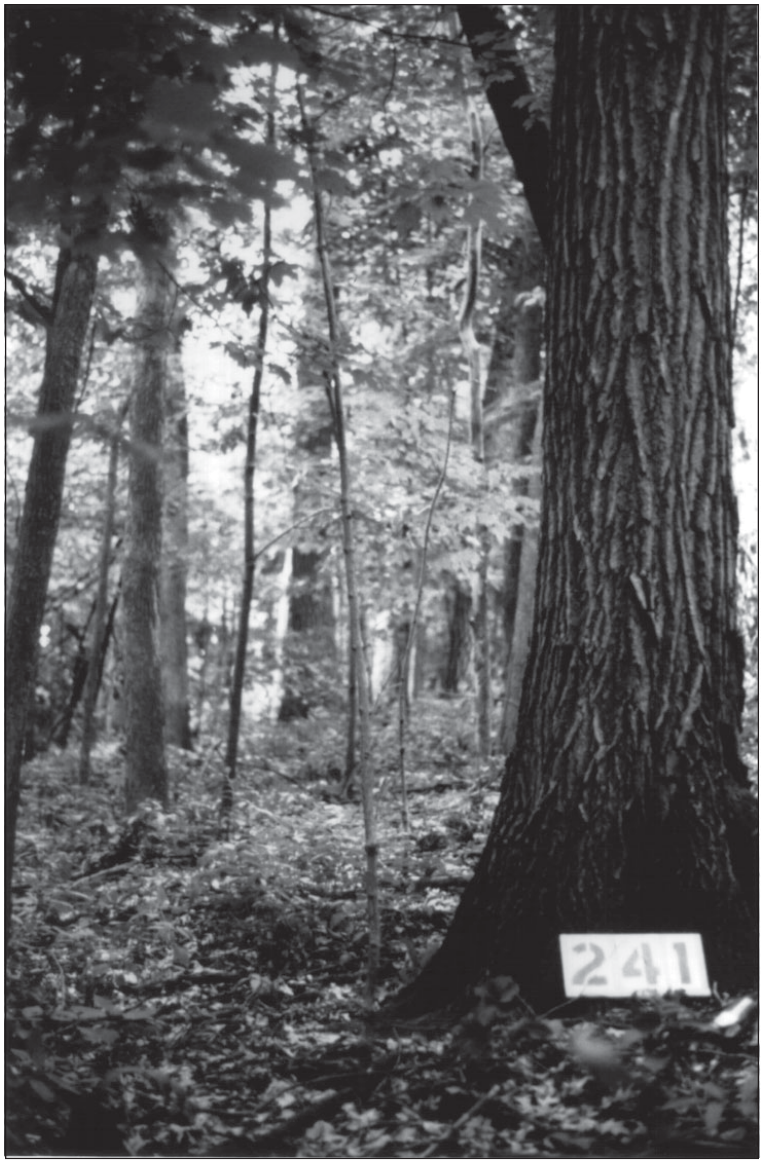

This stand of southern hardwoods is converting from oak to more tolerant species such as ironwood and red maple. *Photo by John Kotar.*

In order to maintain and restore a diversity of forest communities, extensive education of forest owners and the public will be required.

comm.). Roads near breeding areas are also a threat along with the "clean-yard" practices of homeowners building in woodlots.

Gypsy moth control efforts pose a serious threat to native lepidopterans. Aerial application of the biological control agent *Bacillus thuringensis* (B.t.) can kill native species larva. Because susceptibility to B.t. is dependent on the time of emergence, and time of emergence is variable over several weeks, native lepidopterans with synchronous emergence patterns are equally vulnerable to mortality. Agricultural pesticide use is also of concern for the invertebrate community.

Of increasing concern for the southern forest is the artificially maintained high deer density. There is now evidence that in many areas forest regeneration may be frequently reduced by deer browsing.

Socio-Economic Issues

As in all forested regions, conflicts between traditional uses of forests, recreational demands, and concerns for preserving natural communities is intensifying. Numerous misconceptions about the nature of forest ecosystems exist among forest owners as well as the general public. The process of change through natural succession is seldom appreciated. Forest owners too often agree to sell only the highest quality trees, usually oaks, and thus slowly convert their woodlots to tolerant hardwoods. On the other hand, the general public often sees any disturbance, particularly clearcutting and fire, as unnatural and always detrimental. In order to maintain a desired diversity of forest communities, extensive education of forest owners and the public will be required. Because most of the forest land in southern Wisconsin is in private ownership it may seem that public opinion does not matter. However, the public everywhere is becoming progressively more proactive, and its influence on the legislature and the courts is increasing. We should expect management decisions to be increasingly questioned.

Potential for Community Restoration

If the desired state is considered to be some representation of all presettlement forest communities, considerable difficulties will be encountered with its implementation. Restoration of oak savannas would be the most difficult, both from an ecological as well as an economic standpoint. Intensive management through the use of fire would be necessary, and without economic incentives it is not likely to be applied to private lands. Restoration and maintenance of mixed oak forests is certainly possible from the ecological point of view, but greater economic incentives and

technical support will be needed to enable landowners to apply proper management techniques. Without such incentives and support, high-grading and degradation of oak forests are likely to continue. Mesic forest restoration and maintenance would be relatively easy. However, because of direct competition with farming, most forest communities will probably remain confined to terrain unsuitable for cultivation.

Today, large tracts of floodplain are limited to the Lower Wisconsin and Mississippi river valleys; most of the southeastern floodplain forests have been destroyed or reduced to small patches. Large areas of upland forest are restricted to parts of Crawford and Vernon counties, the Baraboo Hills, the northern unit of the Kettle Moraine State Forest, and parts of Manitowoc County. The potential for restoring additional large tracts of each forest type is relatively good in at least some areas of both western and eastern Wisconsin. There are also a number of swamp and bog forests still intact, though often degraded, in the south-central and southeastern counties. Many of these forests have been reduced in size by drainage, agricultural encroachment, and grazing; however, many could be restored over time by reversing the drainage processes.

The best way to enhance biodiversity across the southern forest landscape is to increase the size of individual woodlots and reduce their fragmentation. Achieving this goal will be difficult, but potential does exist in some parts of the southern forest.

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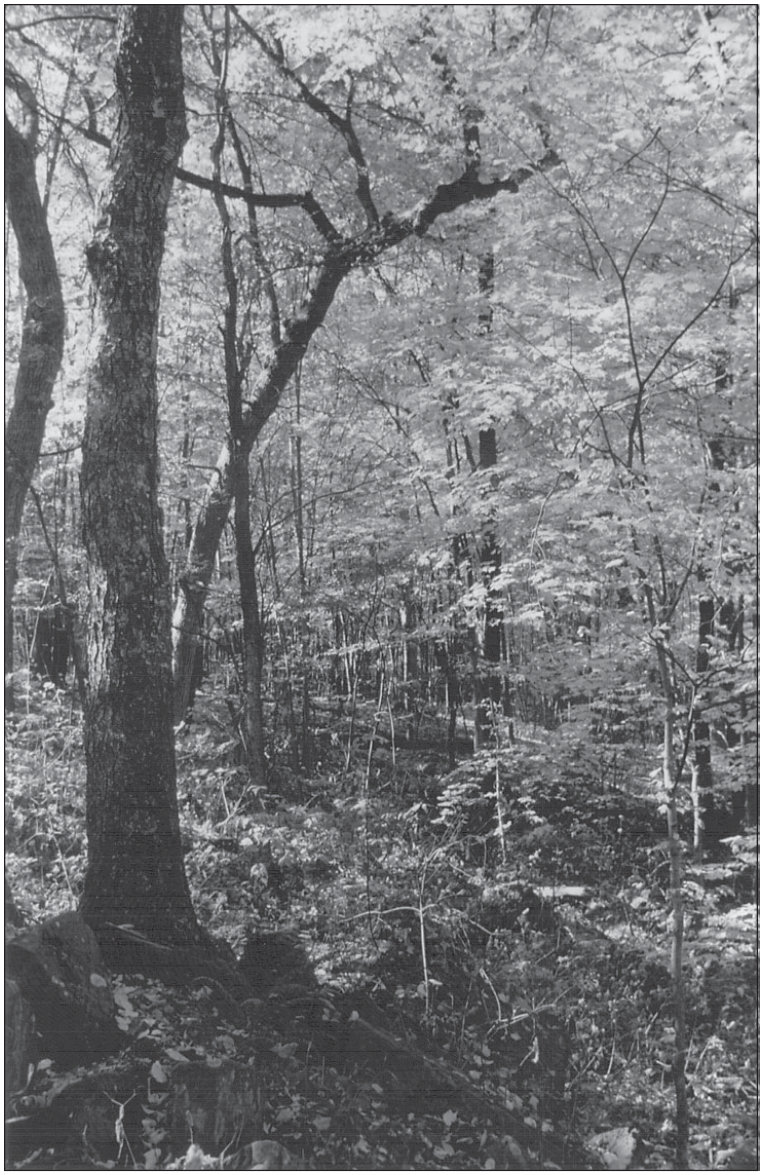

Mature southern mesic forest of sugar maple and basswood. Lost Lake State Natural Area in the eastern end of the Baraboo Hills. *DNR photo*

Possible Actions

The following possible actions are consistent with ecosystem management, but require more analysis and discussion. How priorities are set within this list will be based on ecoregion goals, staff workload, fiscal resources, public input and support, and legal authority. We will work with our customers and clients to set priorities and bring recommendations to the Natural Resources Board for consideration beginning in the 1995-97 biennium.

1. Community-specific actions:

Mesic Forest (including oak-dominated forests with presence of shade-tolerant mesic hardwoods such as sugar maple,

Mixed oak and hickory stands do not regenerate without periodic disturbance. This stand of young oak is growing back after clearcutting. *Photo by John Kotar.*

American beech, basswood, white ash, or bitternut hickory). Mesic forests are relatively stable. In the absence of periodic major disturbances, the dominance of shade-tolerant hardwoods increases. Mixed composition can be maintained with proper silvicultural techniques (e.g., shelterwood, group selection, clearcutting). For optimal biodiversity, some mesic forests should be maintained in a mixed state. Because southern mesic forests were never extensive, even before Euro-American settlement, it is recommended that they be maintained wherever they still occur.

Mixed Oak and Oak-Hickory Forest. Where no tolerant hardwoods are present, these forests are not threatened by succession; however, neither do they regenerate without periodic disturbance. It is recommended that these forests be maintained by appropriate silvicultural methods, including prescribed burning. While no single method has been shown to work in all situations, a number of techniques have been used successfully across a range of site types.

Oak Openings (Savanna). Although this community type is treated in detail separately in this report, it is included here because it is dynamically related to oak forests. Oak openings and savannas in general are among the rarest community types in Wisconsin. Over most of their former range, they have been eliminated by farming or have naturally converted to closed-canopy oak woodlots. Restoring these community types would clearly enhance local as well as regional biodiversity. Although restoration methods are still in developmental stages, it is almost certain that prescribed burning rather than mechanical manipulation of vegetation will be required. Because of predominantly private ownership, large-scale restoration of these communities will be difficult without providing additional economic incentives.

Because the conifers are rare in southern Wisconsin's forest communities, restoring the presence of white pine and its associated communities to their previous southern range would enhance biodiversity.

Mixed Pine-Oak Communities. With the exception of the "central sands" region and a narrow belt along the shores of Lake Michigan, pines have not generally been considered as a natural component of southern forest. However, a number of scattered oak-white pine communities (e.g., Devil's Lake State Park) and several

white pine relicts suggest that this type could be maintained on many landscapes. White pine and red oak have similar ecological requirements and the two species can be managed together. Because the conifer component is rare in southern Wisconsin's forest communities, restoring the presence of white pine and its associated communities to their previous southern range would enhance biodiversity.

2. Old-growth restoration and maintenance areas in southern mesic forests should first be addressed on Department lands where the largest southern mesic forest tracts remain. Areas of remnant old growth should be maintained and enhanced by allowing surrounding forest to attain old-growth condition through natural processes. On appropriate Department lands, designated old-growth areas can be enhanced by surrounding each with a mature forest management zone based on selection harvest practices (see the "Northern Forest" section Possible Actions). Private woodland owners should be encouraged to apply selection management practices, which would allow trees to reach a much older age before harvest and would build old-growth structural characteristics into their forests. Where woodlands occur in close proximity, encourage blocking through the reforestation of intervening open lands, thus enhancing mature old-growth forest characteristics of the existing patches. Encourage participation in private forest assistance programs such as the Managed Forest Law and the U.S. Forest Service Stewardship Incentive Program.

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3. Whenever possible, reduce fragmentation of woodlots by enlarging current blocks and providing wooded corridors through reforestation.

4. Work toward the development of economic incentives for private landowners to enable them to participate in resource management programs that protect biodiversity. Only through such programs will it be possible to implement the specific recommendations listed in this report on a region-wide basis.

5. In order to coordinate management practices consistent with state-wide objectives, some type of regional "information center" will have to be created. For example, a land manager on a given property may be taking all the correct measures to optimize local biodiversity, but without some source of information on wider, regional needs he/she may nevertheless be acting inappropriately. In order to allow for more natural type conversions (through succession), there will be a need for planning regional rotations of cover types. Forest nurseries are producing a much greater diversity of planting stock, including pioneer species such as aspen, because management through natural succession must go hand in hand with the establishment of compensating pioneer stages.

6. Bring together the large amount of existing technical information on silviculture, forest ecology, and wildlife ecology by establishing a natural community information system. The system should have the following characteristic:

   - A basic inventory of wildlife species.

- A basic inventory of wildlife habitats and plant communities.
- A basic model of the relationships of wildlife species to these habitats (Verner et al. 1986).
- A computerized storage and retrieval system.
- Procedures for applying species habitat relationships to integrate resource planning and management.
- Guidelines for managing special habitats or stand conditions.
- A monitoring strategy.

Case Study

The Baraboo Hills: Partners Protecting and Managing in an Ecosystem Context

Contributed by Eric Epstein and Becky Isenring.

The ancient quartzites of the Baraboo Hills rise hundreds of feet above much of the surrounding landscape. Thin soils, steep slopes, low fertility, and public interest discouraged the intensive development now characterizing the vast majority of southern Wisconsin. Today the Hills are mantled with the most extensive upland deciduous forests (totalling about 55,000 acres) remaining in the southern part of the state. In a landscape dominated by agriculture, where most remnant natural vegetation occurs in small, isolated, and often highly disturbed stands, the Hills are an oasis for one of the most diverse arrays of natural communities, plants, and animals in the upper midwest.

Devil's Lake is imbedded in the Baraboo Hills and the most extensive forest in southern Wisconsin. The band of continuous forest of the south range of the Hills narrows at this point from a wider band to the west. *Photo by Michael J. Mossman.*

Naturalists, conservationists, and scientists from many disciplines have been drawn to the Baraboo Hills for well over a century. In 1911, the creation of Devil's Lake State Park marked the first effort to protect a portion of them in perpetuity. The state purchased and acquired other significant properties in the years that followed, including Parfrey's Glen (Wisconsin's first State Scientific Area), Natural Bridge State Park, Lost Lake State Natural Area, McGilvra Woods State Natural Area, and Pewit's Nest State Natural Area. Significant conservation ownerships are also held by the University of Wisconsin Foundation (Potter Preserve), the University of Wisconsin-Baraboo (Van Zelst Barrens), the Village of Rock Springs (Weidman Park), and Wisconsin Society for Ornithology (Honey Creek).

The Nature Conservancy (TNC), a private conservation organization with a large membership and history of involvement in the Baraboo Hills protection efforts dating back some thirty years, is a leading partner. Many of their active projects are focused on the most ecologically important sites in the Hills, including Baxter's Hollow, Hemlock Draw, Pine Hollow, and Misty Valley.

Until recently, most of the conservation work in the Hills had been devoted to individual projects. To take advantage of the unique opportunity for protection and management at a large scale, it was clear that a unified, expanded vision encompassing the scope and attributes of the entire ecosystem was necessary.

In 1991, TNC took a major step to support this vision by initiating a two-year biological inventory in parts of Sauk and Columbia counties, targeting an area of 144,000 acres. The area inventoried was defined principally by the underlying Baraboo quartzite. Field staff included ecologists, botanists, and zoologists. Information was collected on all types of natural communities occurring in the Baraboo Hills, and on many plant and animal species. DNR personnel from the Bureaus of Research, Endangered Resources, Parks and Recreation, and Forestry provided assistance through training, consultation, and development of sampling design. Many individuals in these programs also contributed personal records to the Baraboo Hills Inventory. The Natural Heritage Inventory provided existing computerized records for the area surveyed, a database to store and maintain records, a format to record field data, and a methodology for ranking natural communities and rare species populations.

To meet the existing and anticipated needs of forest managers in the Hills, vegetation data were collected by TNC's inventory teams under the guidance of the UW-Madison's Forestry Department. These data are being analyzed to identify habitat types, as part of a statewide Forest Habitat Classification system.

Other key partners in this endeavor included the UW-Madison herbarium staff (specimen identification), U.S. Forest Service (Forest Stewardship Fund), UW-Stevens Point (Biotic Index analysis of stream samples), numerous volunteers, and the cooperation of numerous landowners who willingly gave inventory staff access to their properties.

To enhance the value and utility of the data collected through inventory, TNC worked with the UW Land Information and Computer Graphics Facility and the UW Institute for Environmental Studies to develop a GIS for the Baraboo Hills. Information incorporated into this system includes Natural Heritage Inventory data, "presettlement" vegetation, current land ownership, natural community covers, and geology. A computer model simulating the effects of land-use changes on neotropical migrant birds has been adapted using the GIS.

Today, an exceptional opportunity exists in the Baraboo Hills to protect and manage an existing functional, diverse, forested ecosystem. The inventory has documented the ecological context for the Baraboo Hills. The new technologies have provided tools to aid in the synthesis and analysis of the information available. Now, many different public and private interests will work to support local and county leadership as plans for the future come into place. These plans will need to incorporate the inventory and other ecological, socio-economic, and political information and provide strategies to address threats, resolve conflicts, and ensure long-term success. Strong commitment to the eventual success of this unprecedented project is needed from all partners, public and private, large and small.

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